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(54) [Title of Invention]: **PROCESS FOR THE MANUFACTURE OF POWDER SLURRY COATING**

(57) Abstract

[Problem]

To provide a process capable of continuously manufacturing a small-particle-size powder slurry coating without using an organic solvent.

[Means Used to Solve the Problem]

The invention relates to a process for the manufacture of a powder slurry comprising:

1) heating a resin melt (a) obtained by heating and fusing a mixture of a powder coating synthetic resin, a hardener and/or photoinitiator, optionally with a coloring pigment, along with an aqueous medium (b) raised to a temperature near the softening temperature of said synthetic resin by heating, optionally, further pressuring;

(2) emulsifying said resin melt (a) in the aqueous medium (b) by a mechanical means while the temperature of the mixture is kept near the softening temperature of said synthetic resin; and

(3) Immediately quenching.

[Claims]

[Claim 1]

A process for the manufacture of a powder slurry comprising:

[illegible]

[illegible]

[illegible]

(2) emulsifying said resin melt (a) in the aqueous medium (b) by a mechanical means while the temperature of the mixture is kept near the softening temperature of said synthetic resin; and

(3) immediately quenching.

[Claim 2]

A process for the manufacture as set forth in Claim 1 wherein after quenching, a viscosity regulator is added to the resultant resin fine particulate aqueous dispersion.

[Claim 3]

A process for the manufacture as set forth in Claim 1 or Claim 2 wherein said powder coating synthetic resin includes at least one type selected from group consisting of acrylic resins, epoxy resins, and polyester resins.

[Claim 4]

A process for the manufacture as set forth in Claim 1 or Claim 2 wherein said powder coating synthetic resin comprises an unsaturated polyester resin and a urethane [poly]acrylate, and/or a urethanized [poly]vinyl ether.

[Claim 5]

A process for the manufacture as set forth in any one of the Claims 1-4, further comprising using, as a mechanical means for emulsification, a high-speed-revolution type continuous emulsifier apparatus having a ring stator with slits and a ring rotor with slits mounted coaxially in such a way as to cause said stator to mutually enmesh with said rotor with small gaps therebetween.

[Claim 6]

A process for the manufacture as set forth in Claim 5, comprising

feeding a mixture of a resin melt obtained by heating and melting a mixture of a powder coating synthetic resin, hardener and/or photoinitiator, optionally with a colorant pigment with an aqueous medium to said high speed-rotation type continuous emulsifier apparatus; and

[illegible] said [illegible] and gaps by high speed

thereby subjecting the mixture to a shear force when it passes through the slits of the aforementioned stator and the slits of the rotor; and

at the same time subjecting said mixture to a shear stress while said mixture is passed through the gaps between said stator and the rotor; whereby the resin melt is emulsified in the aqueous medium.

[Detailed Explanation of the Invention]

[0001]

[Technical Field of the Present Invention]

The present invention relates to a process for the manufacture of a powder slurry coating (containing a UV curable powder slurry coating, hereafter) which is used in technical fields such as coating and the like.

[0002]

[Prior Art]

For processes for manufacturing powder coating or the like, there have heretofore been wet processes and dry processes. The wet process in practice calls for preparing a coating using essentially the same method used in the conventional solvent-based coatings and distilling off solvent, followed by pulverizing or injecting and dispersing a solution of resin into a large amount of a non solvent, filtering, drying, or else spraying the coating into heated air, thereby removing the solvent and the like. However, the process has many technical problems and is more costly compared to the current dry process, hence the wet method is not used in practice.

[0003]

The dry process comprises various steps of mixing, heat fusing, and milling a variety of raw materials, and then cooling, pulverizing, and classifying. The process for an organic solvent free coating is anticipated to make much progress in the future.

[0004]

However, the dry process suffers from the following series of

[0005]

2) The smaller the size, the greater the increase in the pulverization energy necessary per unit powder weight, resulting in higher cost. A recent trend in powder coating dictates improved surface smoothness and gloss which requires the average particle size of the powder coating to be even smaller to the extent that the emergence of a super fine particle coating of 10μ or less is expected in the near future, However, the powder coating prepared by a conventional pulverization process technology will make the manufacture very difficult, and even if possible, the cost would be higher.

[0006]

3) Among powder coatings are the UV curable powder coatings, which have a softening temperature of 60 100°C, which is lower than that of the conventional powder coatings. Accordingly, the pulverization process for the manufacture of a UV curable powder coating must necessarily involve a treatment which will not cause the powder to fuse together.

[0007]

It is very difficult to overcome the above problem by the conventional wet or dry processes. The powder slurry coating of this invention can however, be manufactured by emulsifying the type of powder coating obtained above, in an aqueous medium.

[0008]

[Problems to be Solved by the Invention]

It is an object of this invention to fundamentally improve the prior processes, thereby to propose a manufacturing process for a powder slurry coating which overcomes its associated problems.

[0009]

Specifically, the present invention provides a process for the manufacture of a powder slurry coating, which does not need the pulverization step as does the dry process.

The present invention provides a simple and high productivity continuous manufacturing process which can easily manufacture the powder coating with 10μ or less, super-fine particles.

The present invention provides a manufacturing process which makes it easy to manufacture a difficult-to-pulverize low softening temperature UV curable powder coating, which eliminates the pulverization step.

[0011]

The invention provides a process which makes it unnecessary to have an installation such as a powder coating line, providing a manufacturing process that can be introduced to an existing aqueous coating line with an essentially no modification.

[0012]

[Means Used to Solve the Problem]

The present inventors have extensively repeated trial and error studies to determine whether or not it was possible to produce a powder coating with the advantages of both the dry process and the wet process that does not use any organic solvent at all and produces the spherical fine particulate powder coating as does the wet process, and as a result, they have discovered that the task can be achieved by way of mechanical emulsification in a continuous emulsifier apparatus and have arrived at the present invention.

[0013]

The present invention is a process for the manufacture of a powder slurry comprising: (1) heating a resin melt (a) obtained by heating and fusing a mixture of a powder coating synthetic resin, a hardener and/or photoinitiator, optionally, with a coloring pigment, along with an aqueous medium (b) raised to a temperature near the softening temperature of said synthetic resin by heating, optionally, further pressuring; (2) emulsifying said resin melt (a) in the aqueous medium (b) by a mechanical means while the temperature of the mixture is kept near the softening temperature of said synthetic resin; and(3)immediately quenching; wherein preferably the powder coating synthetic resin includes at least one type selected from group consisting of acrylic resins, epoxy resins, and polyester resin or an unsaturated polyester resin and

Furthermore, it is a process for the manufacture of a powder slurry using, as a mechanical means for emulsification, a high speed rotation type continuous emulsifier apparatus having a ring stator with slits and a ring rotor with slits mounted coaxially in such a way to cause said stator to mutually enmesh with said rotor with small gaps therebetween; in addition, it is a process for the manufacture of a powder slurry comprising feeding a mixture of a resin melt obtained by heating and melting a mixture of a powder coating synthetic resin, hardener and/or photoinitiator, optionally with a colorant pigment with an aqueous medium to said high speed rotation type continuous emulsifier apparatus; and passing said mixture through said slits and gaps by high speed rotation of said rotor so as to move the mixture away from the inner center of the rotor in a centrifugal direction; thereby subjecting it to a shear force when it passes through the slits of the aforementioned stator and the slits of the rotor; and at the same time subjecting said mixture to a shear stress while said mixture passes through the gaps between said stator and the rotor; whereby the resin melt is emulsified in the aqueous medium.

[0015]

[Embodiment for Carrying Out the Invention]

The present invention is a powder slurry coating manufacturing process (hereafter aqueous emulsification process) obtained by mechanically emulsifying resin fine particles without using any solvent in an aqueous medium, thereby generating a powder slurry coating comprised of the resultant aqueous dispersion, and it entails three steps.

[0016]

The first step of this invention is explained. It is a step of heating a resin melt (a) obtained by heating and fusing a mixture of a powder coating synthetic resin, a hardener and/or photoinitiator, optionally, with a coloring pigment, along with an aqueous medium (b) raised to a temperature near the softening temperature of said synthetic resin by heating, optionally, further pressuring.

[0017]

Any synthetic resin for powder coatings may be used in this step as

of an unsaturated polyester resin with a urethane acrylate or a urethanized vinyl ether is suitable as a UV curable type powder coating resin, but acrylic resins, polyester resins, epoxy resins, and the like, are suitable as ordinary powder coating resins.

[0018]

Any hardeners and photoinitiators may be used as long as they are suitable for powder coatings. The hardeners include, for example, polycarboxylic acids (dodecane dicarboxylic acid, trimellitic acid, and the like, amino resins, blocked polyisocyanates, poly epoxides, polyols, and the like. The photoinitiators include, for example, acetophenone, benzophenone, Michler's ketone, benzyl, benzoin, benzoin butyl ether, benzyl dimethyl ketal (Irgacure-651), 1-hydroxy cyclohexyl phenyl ketone (Irgacure 184), 1-hydroxy-2-dimethyl-1-phenyl propane-1-one, 1-(4-isopropyl phenyl)-2-hydroxy-2-methyl propane-1-one, azobisisobutyronitrile, benzoyl peroxide, di-tert-butyl peroxide, and the like.

[0019]

The hardener and photoinitiator may be used by themselves or in combination of both, depending upon the synthetic resin types. The synthetic resin may be optionally compounded, with a hardener and photoinitiators, optionally, with coloring pigments. The coloring pigments are organic pigments, inorganic pigments, and the like. The organic pigments include, for example, azo pigments, phthalocyanine pigments, condensed polycyclic pigments, nitroso pigments, and the like; the inorganic pigments include, for example, oxide pigments, phthalocyanine derived compounds, chromate salt pigments, carbon type pigments, mica pigments, metal powder pigments, and the like.

[0020]

These pigments may be further be optionally compounded with additives such as fillers, anti corrosion agents, UV stabilizers, UV absorbers, flow regulators, anti-crawling agents and the like. These raw materials are milled together, heated, and fused to generate a resin melt. Known methods are used for producing these resin melts. Specifically, if a hardener is not incorporated, the synthetic resin,

optionally a photoinitiator, coloring pigment, and additive are dry blended in a mixer, then sent to a screw mixer, heated, melted, and milled in an extruder; the milled product is directly transported to the rotary type continuous emulsifier apparatus described below.

[0021]

The aqueous medium used in this invention is now explained. In general, aqueous media are basically water to which optionally, a dispersing agent and a surfactant may be added for producing an aqueous stable resin melt dispersion. There is no particular limitation as to the dispersing agent, which includes, for example, aqueous soluble polymer dispersion stabilizers such as polyvinyl alcohol and hydroxy ethyl cellulose, which are frequently used in suspension polymerization of styrene or the like, or sparingly water soluble inorganic dispersion stabilizers such as calcium phosphate and the like. Any suitable one from among these may be used. There is no particular limitation as to the type of surfactant which, for example, includes 2,6,8-trimethyl-4-nonyloxy polyethylene oxyethanol and the like.

[0022]

The ratio of the aqueous medium to the synthetic resin must be in an amount sufficient for producing an aqueous emulsion. The solvent free aqueous emulsification process in this invention features heating the synthetic resin melt and the aqueous medium to a temperature near the softening temperature of the resin. The temperature near the softening temperature is not particularly limited, but it should be within ± 30°C for retention of the synthetic resin in the molten state.

[0023]

The above aqueous medium is one at a high temperature reached by heating at atmospheric or optionally a higher pressure. A heat exchanger for heating or the like, is used to heat up to a temperature near the softening temperature of the synthetic resin for melting the powder coating synthetic resin. For this purpose, the aqueous medium may be pressurized, depending upon the softening temperature of the synthetic resin used so as to bring it to a suitable temperature with the assistance of pressurization in the step up to a pressure of about

softening temperature is 100°C or above, pressurization must be used to prevent the aqueous medium from boiling.

[0024]

Next the second step of this invention is explained. The second step is the mechanical emulsification of the resin melt in the aqueous medium while the mixture of the resin melt and the high temperature aqueous medium obtained in the above first step for the resin are maintained at a temperature near the softening temperature of the synthetic resin.

[0025]

There is no particular limitation as to the device used for mechanically emulsifying the resin melt in the aqueous medium while the temperature is maintained near the softening temperature of the synthetic resin, but it is preferred to use a high speed rotary type continuous emulsifier apparatus having a ring stator with slits and a ring rotor with slits mounted coaxially in such a way to cause said stator to mutually enmesh with said rotor with small gaps therebetween

[0026]

The high speed rotary continuous emulsifier apparatus of this invention is a device so structured that the resin melt and the aqueous medium can be continuously pressure fed under high pressure and high temperature at 100°C or higher, and rapidly and uniformly mixed to emulsify under the high pressure and high temperature at a temperature near the softening temperature of the synthetic resin, but below the decomposition temperature of the synthetic resin, thereby continuously enabling a discharge.

[0027]

The high speed rotary type continuous emulsifier apparatus by virtue of the rotors rotating at a high speed can emulsify the synthetic resin melt in the aqueous medium. In order to maintain the synthetic resin at a constant melt state, the temperature of the mixture must be maintained at a temperature near the softening temperature of the

the resin molecular weight and the like, but it is preferably set at 80°C 220°C.

[0028]

The temperature within the high speed rotary type continuous emulsifier apparatus is maintained at a constant value by virtue of a balance struck between the temperatures of the fed resin melt and aqueous medium, the jacket temperature holding effect, and the shear forces within the emulsifier apparatus.

[0029]

The pressure of the high speed rotary type continuous emulsifier apparatus will depend upon the vapor pressure of the aqueous medium at the emulsifier apparatus temperature and the discharge pressure due to the pumping function of the rotor. Normally, it is preferred to use a process calling for an automatic pressure regulating valve installed after the step of cooling the aqueous dispersion of the fine resin particles, thereby maintaining the internal pressure constant and continuously discharging the aqueous dispersion at atmospheric pressure.

[0030]

In the high speed rotary type continuous emulsifier apparatus, the mixture of the resin melt and the high temperature aqueous medium is fed to the high speed rotary type continuous emulsifier apparatus and passed through the slits and gaps by high speed rotation of said rotor moving the mixture away from the inner center of the rotor in a centrifugal direction, subjecting it to a shear force when it is passed through the slits of the stator and the slits of the rotor; and at the same time subjecting it to a shear stress when the mixture is passed through the gaps between said stator and the rotor, thereby undergoing a micro dispersion. The stator and rotor slits are such that either the stator or rotor slits or both may be replaced by nozzles which can provide a similar effect.

[0031]

The high speed rotary type continuous emulsifier apparatus, which [illegible]

[illegible] The circular face [illegible] provided with

protrusions 3 in a concentric ring manner, in single, double, or higher multiple steps. The gaps between the protrusions have circumferential grooves 4 so as to generate a plurality of slits 5. These slits are 0.6mm 3.0mm wide; 12 72 slits are provided on each ring protrusion in a comb-tooth like manner. In order to reduce the particle size of the liquid fed, it is preferred for the width of the slits to diminish towards the outer circumference of the rotor and stator.

[0032]

In the center of the other interior wall within the high speed rotary continuous emulsifier apparatus is mounted a drive shaft 6, which is connected to a drive capable of high speed rotation. The rotors 7 in the high speed rotary type continuous emulsifier apparatus located at the tip of the drive are secured parallel to the stator and coaxially along the same center shaft. The counter face of the rotor, which faces the stator, is provided with a single, double, or multiple step of protrusions, 8, in a concentrically annular manner with respect to the rotor. Each rotor protrusion, as in the stator, has a circumferential groove, 9, in the gap between the protrusions themselves, thereby, producing a plurality of slits, 10, on each protrusion.

[0033]

The stator 1 and the rotor 7 are placed in service with the protrusions 3 and circumferential grooves 4 of each stator held in an enmeshed state of insertion with a small gap between the protrusion 8 and circumferential groove 10 of the rotor.

[0034]

The mixture of the resin melt and high temperature, high pressure aqueous medium is fed through the gaps generated by this enmeshing in the high speed rotary type continuous emulsifier apparatus used in this invention so that said mixture is caused to flow away from the inner center of the rotor in a centrifugal direction and is subjected to a shear force by the high speed rotation of the rotor and to a shear stress while said mixture passes through the gap between said stator and the rotor whereby the resin melt is emulsified in the aqueous medium.

rotation, the innermost rotor protrusion slits and is expelled from the outer circumference of said rotor protrusion by a centrifugal force to be pushed against the innermost stator protrusion, entering that stator's protrusion slit. The liquid mixture entering the slit is pushed by the mixture entering the innermost rotor slit by a centrifugal force to be pushed to the circumferential groove of the second rotor. The mixture is then subjected to a shear force by the innermost stator protrusion and the second rotor protrusion, at the same time, and to a shear stress as the mixture passes through the gap between the stator and rotor. When the liquid mixture becomes confluent, a shear stress is further applied thereto, and the mixture is pushed by the mixed liquid behind it entering the second stator protrusion slit, so that it will be repeatedly subjected to the same situation as above, so the mixture is sequentially caused to move in a centrifugal direction, thereby completing a micro-dispersion.

[0036]

The relationship between the flow of the mixture and the shear force and shear stress is as given in Figure 4. The number of revolutions of the rotor in the high speed rotary continuous emulsifier apparatus is controlled by the drive motor connected to the drive shaft. The greater the number of revolutions and the higher the circumferential speed, the greater the shear stress, the smaller the synthetic resin particle size will become. The preferred speed of revolution is 3,000-10,000rpm for a rotor with a 10cm diameter for the production of a powder coating having an average particle size not more than 10μ.

[0037]

An example of a device on the market as a high speed rotary type continuous emulsifier apparatus of this invention includes a "Cavitron" (manufactured by Yurotech KK). The third step of this invention is explained below.

[0038]

The aqueous resin fine particle dispersion collected from the exit of the above high speed rotary continuous emulsifier apparatus, before the resin particles themselves have been[ ] allowed to collide with each

[0039]

The device used for quenching may be a heat exchanger of the type on the market so as to cool by heat exchanging with chilled water. The cooling rate, which is not particularly limited should preferably be at least 10°C sec so as not to generate any coagulant.

[0040]

After the synthetic resin has been cooled to near its glass transition temperature, the pressure is reverted back to atmospheric by a pressure regulating valve to give a fine particulate resin slurry. This slurry may be directly used as a powder slurry coating but may be optionally mixed with a viscosity regulator. Addition of a viscosity regulator will give a suitable rheology for spray coating, thereby holding the floating fine resin particles [in suspension]. The viscosity regulators include, for example, an acrylic resin, specifically Primaru[transliterated] Ase 60 (manufactured by Nippon Acryl Kagaku Co.).

[0041]

An example of a flow sheet from the above first step to the third step is explained with Figure 5. A resin melt is fed from a tank 12 containing a resin melt manufactured by the above method via a resin pump 13 to a high speed rotary type continuous emulsifier apparatus 11 and at the same time a high temperature aqueous medium is obtained from an aqueous medium tank 14, which holds the aqueous medium at temperature via a heater heat-exchanger 15, thereby generating a high temperature aqueous medium, which is then fed to the high speed rotary type continuous emulsifier apparatus 11 via pump 16. The resin melt and the high temperature aqueous medium are emulsified in the emulsifier apparatus 11, producing an aqueous resin melt dispersion. The aqueous dispersion is passed through a cooling heat exchanger 17 to be cooled to an aqueous resin dispersion. The pressure of the entire flow process is regulated by a pressure regulator valve 18.

[0042]

The powdery slurry coating manufacturing process of this invention can be carried out continuously, involving the series of steps from the resin melt and high temperature aqueous medium via the high speed rotary

As described above, the present invention calls for a solvent-free emulsification of a mixture of the resin melt and a high temperature, high pressure aqueous medium by generating a high shear force, shear stress, and a high frequency pressure level variation, via a high speed rotary emulsifier apparatus, thereby making use of the powerful stirring and pulverization effect.

[0044]

It is essentially unnecessary to wash the synthetic resin particles, although the leaching of aqueous soluble components is not completely zero, but a simple filtration is sufficient. In this respect, the present invention is advantageous for its simple steps and for the continuous operation of the entire series of steps.

[0045]

The controlling factors for the average particle size of the resin fine particles generated are the speed of revolution of the rotors in the emulsifier apparatus, and temperature of the synthetic resin and aqueous medium. Increasing either the speed or the temperature[these controlled factors] will increase the aqueous dispersion capability of the synthetic resin, thereby reducing the size of the fine synthetic resin particles.

[0046]

The fine particulate resin particle slurry is then dewatered, dried, and classified as in the dry process so as to have the desired particle size distribution, thereby generating a powder coating of fine resin particles with specific particle sizes. By further connecting the cooling heat exchanger to a washing, dewatering device, a dryer, and a classifier, one can continuously carry out a series of steps from the resin melt and a high temperature aqueous medium via a high speed rotary type continuous emulsifier apparatus down to drying and classification. Obviously, it is possible to use a continuous process down to the quenching step and the powder slurry thus obtained may then be subjected to the water washing of the resin in a tank, followed by dewatering and drying. For the classification step, one may combine it with a wet type classifier process using a wet cyclone.

Examples of this invention are given below, but the invention is not limited by these examples. In these examples, parts, percentages are all based on weight.

[0048]

[Example 1]

<Preparation of UV Curable Powder Slurry Coating >

Manufacture of urethane acrylate used for UV curable powder slurries.

The following composition was used:

[0049]

Isophorone Diisocyante	58.2 parts
Dibutyl Tin Dilaurate	0.1 part
3,5-di-t-butyl 4 hydroxy toluene	0.3 parts

The mixture was heated to 65°C, followed by dropwise addition of 32.4 parts of hydroxy propyl acrylate and then stirring the mixture until the NCO content dropped to 13% or less. The stirring revolution speed was increased while the contents were gradually heated to 120°C. During this time, 9 parts of glycerine was added dropwise in 1 hour. The resin melt was removed and cooled and pulverized to give a white powder having a softening temperature (ring ball method) of 75°C and a melt viscosity (ICI cone plate viscometer) of 76 dPas at 150°C.

[0050]

Preparation of UV Curable Powder Slurry Coating

A mixture of 100 parts by weight of the above urethane acrylate, 233 parts of Polylite [transliterated] PB958 (unsaturated polyester resin, manufactured by Dainippon Ink Kagaku Kogyo KK), 11 parts of diacetone acrylamide, 15 parts of Irgacure 651 (benzyl dimethyl ketal, manufactured by Ciba Geigy) and 11 parts of BYK 361 (acrylic resin made by BYK Chemie Company) was charged in a mill melter tank illustrated in Figure 5, followed by heating to 110°C and feeding to a Cavitron CD1010 at a rate of 100g/min.

operated at a rotor revolution speed of 8,000rpm under a pressure of $2kg/cm^2$ and the manufactured slurry was chilled within 10 seconds from 110°C to 65°C as it was[and] discharged.

[0052]

The slurry was mixed with 1% by weight of Primaru [transliterated] ASE-60 (an acid containing cross linkable acrylic emulsion, viscosity regulator: manufactured by Nippon Acryl KK) for increasing the spray coatability. The coagulant in the resultant slurry was pulverized by a homogenizer to give a uniform product and filtered through a 400 mesh screen (37μ) to give a UV curable powder slurry having nearly spherical shaped particles with an average particle size of 10μ.

[0053]

Coated Film from the UV Curable Powder Coating

The slurry coating was spray coated onto cold rolled steel panel to about 1mil thickness. The film was then heated for 15 minutes to 100°C to evaporate the water and melt the resin which was then irradiated with a UV lamp (120w/cm, 10m/min, 7pss, $840mj/cm^2$), to give a clear, hard, scratch resistant coated film.

[0054]

[Example 2]

<Preparation of Powder Slurry Coating>

84% of "Finedeck" [transliterated] A-207S (acrylic resin: manufactured by Dainippon Inc Kagaku Kogyo), 16% by weight of a dodecane dicarboxylic acid (hardener), and 0.5% of Akuronarl [transliterated] 4F (flow regulator: manufactured by BASF Company) were premixed and fed to the screw mixer 12 of Figure 5. The screw mixer then fed the mixture to the extruder 13 of Figure 5, which was used to melt and heat the mixture to 100°C to be fed to a Cavitron CD1010 at the rate of 100g per minute. Deionized water containing 0.1% of PVA in the aqueous medium tank of Figure 5 was heated by a heat exchanger to 100°C and fed to the Cavitron at the rate of 1l/min. The unit was operated at the rotor revolution speed of 8.000rpm under a pressure of $2kg/cm^2$; the manufactured slurry was cooled from 100°C to 65°C within 10 seconds as it was[and] discharged

The mixture was mixed with 1% by weight of Primaru ASE 60 to improve the spray coatability, then the coagulated product was pulverized by a homogenizer, followed by filtering through a 400 mesh screen (37μ) to give a powder slurry coating with a nearly spherical particle with an average particle size of 2μ and a ["maximum particle size"] [missing in the text] of not more than 10μ.

[0056]

The slurry coating was spray coated about 1ml thick onto cleaned cold rolled steel[coat pressed] panel and the panel was pre baked for 15 minutes at 100°C and then baked 20 minutes at 150°C to give a clear, hard, and smooth coated film.

[0057]

[Advantageous Effect of the Invention]

The present invention permits production of a small particle size powder slurry coating without using any organic solvents by an extremely easy and high productivity continuous manufacturing process.

[0058]

The synthetic resin particle manufacturing process of this invention can economically produce a powdered product even from a resin which could not have been made into a powder product by the conventional means of pulverization.

[Brief Description of the Drawings]

[Figure 1]

A perspective view of the stator and rotor in the rotary type continuous emulsifier apparatus used in this invention.

[Figure 2]

A drawing showing the cross-section of the essential parts of the rotary continuous emulsifier apparatus of this invention.

[Figure 3]

[Figure 4]

A drawing which shows the force applied to the fluid flowing through the space between the stator and the rotor as the rotor of the rotary continuous emulsifier apparatus used in this invention rotates.

[Figure 5]

A view illustrating the process for the manufacture of such powder slurry coating of this invention.

[Explanation of Symbols]

1 Stator
2 Liquid Inlet
3 Stator Protrusion
4 Stator Circumferential Groove
5 Protrusions Slit
6 Drive Shaft
7 Rotor
8 Rotor Protrusion
9 Rotor Circumferential Groove
10 Protrusion Slits
11 Rotary Type Continuous Emulsifier Apparatus
12 Resin Melt Tank or Screw Mixer
13 Resin Pump or Extruder
14 Aqueous Medium Tank
15 Heating Heat Exchanger
16 Aqueous Medium Pump
17 Cooling Heat Exchanger
18 Pressure Regulator Valve

Figure 1

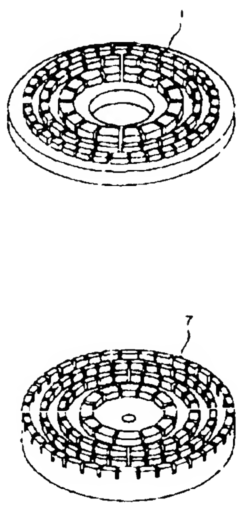


Figure 2

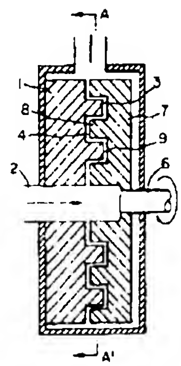


Figure 3

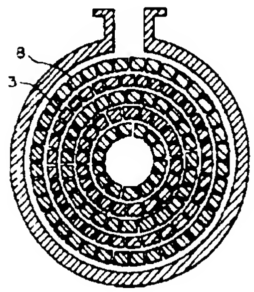


Figure 4

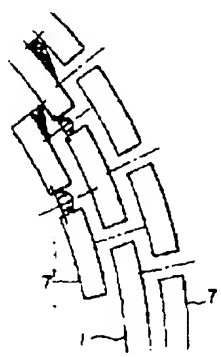
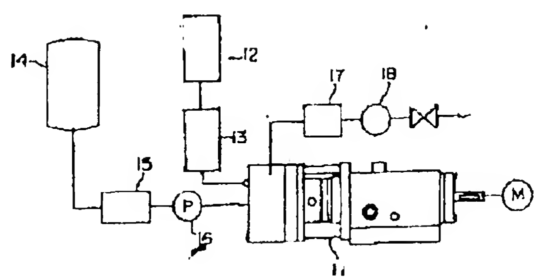


Figure 5



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